# AIRS / AMSU / HSB

## Data Processing and Data Products Quality Assessment Plan

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## Forward to Version 2.2

Version 2.1 of this document was a major restructuring from Versions 1.0 and 1.1, reflecting QA procedures unique to the AIRS system. Those earlier versions were based primarily on the ASTER QA Plan.

This version and version 2.1 of the AIRS QA Plan includes process monitoring activities in addition to ascribing quality flags to individual data product files. Also, AIRS QA will become important in the period several months after launch, and beyond, as the Goddard DAAC takes on the primary data production responsibility. This plan addresses primarily those QA activities to be carried out in the period following the first several months after launch.

Because this Plan is a major revision from earlier versions, this forward does not detail the many minor changes.

Version 2.2 differs from Version 2.1 in the following ways

- The quantities ScienceQualityFlag and some typical ScienceQualityFlagplanation settings have been defined to include valids of Passed, Being Investigated, Inferred Passed, and Suspect

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## Tables and Figures

# 1. Introduction

This plan describes the Quality Assessment (QA) processes and components for the Atmospheric Infrared Sounder (AIRS) Product Generation System (PGS). The AIRS system includes the AIRS instrument plus the two separate instruments comprising the Advanced Microwave Sounding Unit (AMSU), and the Humidity Sounder for Brazil (HSB). The collective AIRS / AMSU / HSB system is commonly referred to 'AIRS' in this document.

The intended audience of this document is AIRS, DAAC and ECS QA personnel, AIRS operations planning personnel, and potential users of AIRS data products, including the AIRS Science Team and the science community at large.

## *1.1. AIRS QA Objectives*

**The goal of AIRS QA is to ensure the consistency and integrity of the AIRS data products as a climate record.** To realize this goal, the AIRS QA plan provides for monitoring the flow of information and data from the instruments, through the data processing system, to the released data products. Thus the AIRS QA emphasizes the overall *process* rather than, and in contrast to, providing quality assessment specific to an individual data product file.

The AIRS quality assessment activities are integral to and coordinated with:

- Instrument Operations
- Instrument Calibration
- Product Validation
- Processing System Monitoring

During the first year each of these activities is planned to bring the full AIRS system -- instruments and data processing -- to operational status. At 12 months after launch, initial instrument calibration and early validation of AIRS data will be complete, and the product generation executive (PGE) that produces retrieved geophysical data will be brought online at the Goddard Space Flight Center DAAC. At this point, the emphasis will shift to maintaining the quality of AIRS data products.

Of these four activities, Instrument Calibration and Product Validation have formal plans (see Supporting Documents section below).

The rough timeline for the QA activities is shown in Figure 1:

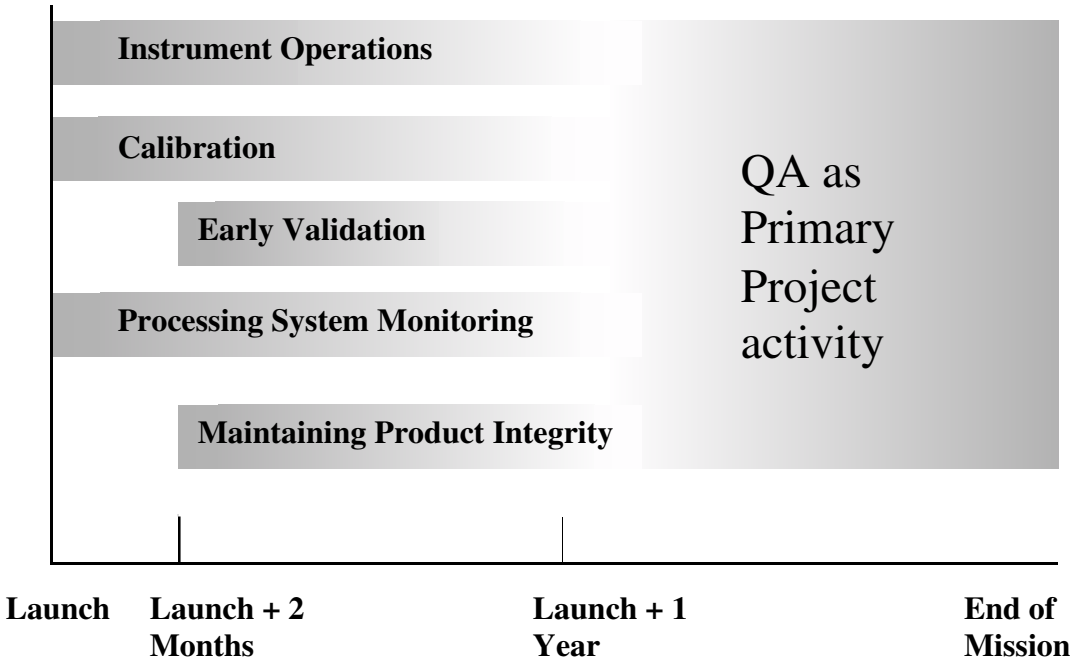


**Figure 1. AIRS activities encompassing Quality Assessment.**

AIRS Quality Assessment utilizes specific data types, including metadata and standard parameters. QA processing is also supported by data subscription from the DAAC to the TLSCF, and data analysis and automatic checking of processing logs. This is illustrated schematically here:

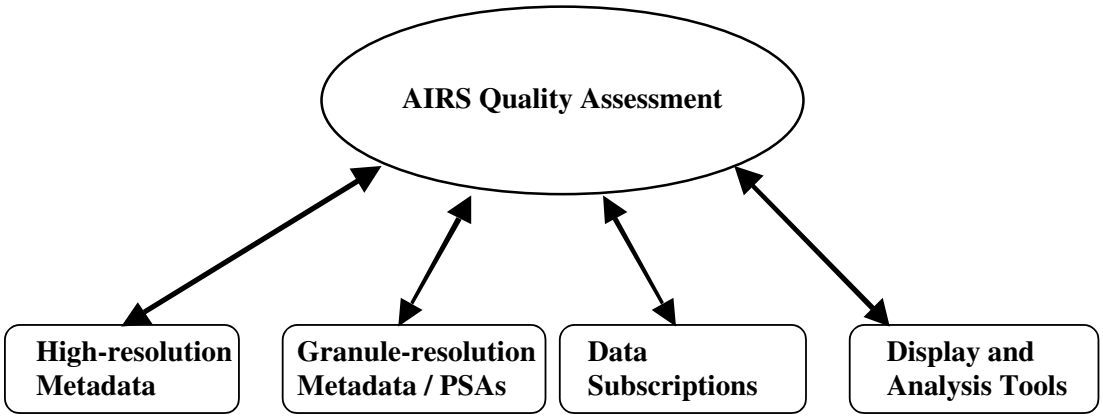


**Figure 2. Activities and products supporting AIRS Quality Assessment.**

## *1.2. Relevant Documents*

The documents listed below with JPL document numbers are available online through a link to the AIRS home page http://airsteam.jpl.nasa.gov/.

### 1.2.1. Supporting Documents

**Atmospheric Infrared Sounder (AIRS) Level 1B Visible, Infrared and Telemetry Algorithms and Quality Assessment (QA) Processing Requirements**, Version 1.0, JPL D-20046, ADF-525, June 22, 2001.

**The AIRS Team Science Data Validation Plan**, Version 2.1.1, JPL D-16822, June 2000.

**AIRS Science and Measurement Requirements Document**, JPL D-6665 Rev 1 September 1991 AIRS Brochure

**AIRS Visible and Infrared In-Flight Calibration Plan**, version 2.0, JPL D-18816, ADFM 412A, May 2001.

**AIRS Level 1B Visible, Infrared and Telemetry Algorithms and Quality Assessing Processing Requirements**, version 1.0, JPL D-20046, ADFM 525, June 2001.

**AIRS Algorithm Theoretical Basis Document, Level 1B, Part 1: Infrared Spectrometer,** JPL D-17003, Version 2.2i, November 10, 2000

**AIRS Algorithm Theoretical Basis Document, Level 1B, Part 2: Visible/Near-Infrared Channels** JPL D-17004, Version 2.2, November 10, 2000

**AIRS Algorithm Theoretical Basis Document, Level 1B, Part 3: Microwave Instruments**, Version 2.1, JPL D-17005, Version 1.2, November 10, 2000

**AIRS Algorithm Theoretical Basis Document, AIRS-Team Unified Retrieval For Core Products, Level 2**, JPL D-17006, Version 2.2, April 26, 2001

**AIRS Version 2.0 Processing Files Description**, Version 4.0, August 2000. JPL D-19555.

**Interface Control Document Between EOSDIS Core System (ECS) and Science Computing Facilities, Revision C**, December 1999. ECS Document 505-41-33.

**Revision to AIRS Calibration PSAs**, ADFM 537, August 20, 2001.

**On-Orbit Microwave Instrument Science Plan**, to be published.

### 1.2.2. Processing Files Description (PFD)

**AIRS Version 2.1 Processing Files Description version** 5.0, January 2001. JPL D-20001.

The Processing Files Description (PFD) is the master list of all AIRS parameters, including QA data. Updates to QA parameters will be reflected as changes in this document. The Product-Specific Attributes are metadata that can be searched. All currently defined Quality Assessment parameters associated with the AIRS instrument suite and the subsequent algorithms are included in the PFD. Updates to QA parameters will be reflected as changes in this document. The PFD contains the following Appendices:

A1-1. L1A AIRS Science Interface Specification
A1-2. L1A AIRS Calibration Interface Specification
A1-3. L1A AIRS QA Subset Interface Specification
A1-4. L1A VIS Science Interface Specification
A1-5. L1A VIS Calibration Interface Specification
A1-6. L1A AMSU Interface Specification
A1-7. L1A HSB Interface Specification
A1-8. L1B AIRS Science Interface Specification
A1-9. L1B AIRS QA Interface Specification
A1-10. L1B AIRS Browse Subset Interface Specification
A1-11. L1B VIS Science Interface Specification
A1-12. L1B VIS QA Interface Specification
A1-13. L1B AMSU Interface Specification
A1-14. L1B HSB Interface Specification
A1-15. L2 Standard Atmospheric/Surface Product Interface Specification
A1-16. L2 Standard Cloud-Cleared Radiance Product Interface Specification
A1-17. L2 Support Atmospheric/Surface Product Interface Specification
A1-18. L2 Retrieval Browse Subset Interface Specification
A1-19. L2 Cloud-Cleared Browse Subset Interface Specification

## *1.3. The AIRS Data Products*

The AIRS data products are described in detail in the Processing File Descriptions and Algorithm Theoretical Basis Documents listed above. The AIRS instrument suite consists of several instruments: an infrared spectrometer, three microwave radiometers, and a visible/near-IR imager sharing optics with the IR spectrometer.

The AIRS products are of four types:

- *Level 0:* Instrument packets. L0 products have no associated QA quantities.

- *Level 1A:* Geolocated radiance in counts, with a 12- to 14-bit dynamic range. L1A QA primarily describes the instruments' states, geolocation, data number to engineering unit conversion and data repacking.
- *Level 1B:* Calibrated radiance in physical units. L1B QA mainly pertains to the calibration process.
- *Level 2:* Retrieved geophysical quantities. L2 QA parameters monitor this complex processing.
- *Level 3:* Quantities mapped to a regular grid in space and time, and some averaging may be involved. The AIRS processing system does not currently produce Level 3 quantities, but a draft Level 3 Requirements Document has been written. Later versions of this plan will include QA for Level 3 products.

Figure 3 shows the flow of data through the AIRS processing software. Each processing step creates associated QA parameters. The QA quantities for Level 1A through Level 2 are listed in the PFD.

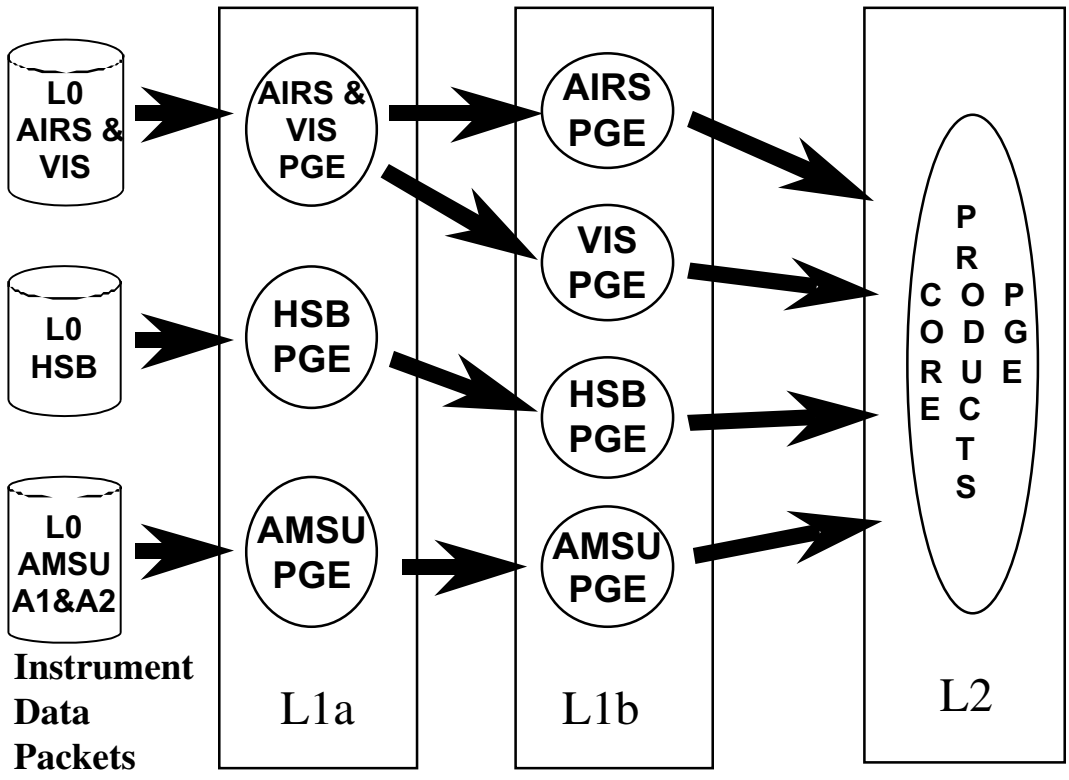


**Figure 3. Simplified representation of the AIRS/AMSU/HSB data processing system and major Product Generation Executives (PGEs) constituting the AIRS Product Generation System (PGS).**

# 2. QA Concepts

## *2.1. Types of AIRS Quality Assessment*

The four types of AIRS QA activities are described here. The flags set during AIRS Quality Assessment and the conditions triggering them are specified in Chapter 4.

### 2.1.1. Operational Assessment

Operational Assessment monitors the state of the processing system, including computing and storage media, input files, and numerical anomalies such as floating point exceptions. The DAAC has responsibility for Operational Assessment.

The *OperationalQAFlag* is described in Chapter 4 below. Evaluating the *OperationalQAFlag* is the primary QA responsibility of the DAAC.

### 2.1.2. Automatic Assessment

Automatic Assessment is based on checking a select set of granule-level quantities against well-specified criteria, as defined in Chapter 5. Determining these criteria is part of ongoing QA development activities. Automatic Assessment sets the *AutomaticQAFlag*. It is discussed in Chapter 4.

### 2.1.3. Manual QA

Manual Assessment falls into three General Categories:

- *Routine Manual QA* will monitor a select set of parameters. During the first months of instrument operations Routine Manual QA monitoring will be the prevalent QA activity. Many of these parameters examined during the first months after launch will later be included in Automatic Assessment and Operational Assessment as the instruments stabilize.

- *Long-term QA Monitoring* will be performed on a select set of QA parameters to assess system performance. The AIRS system is expected to become stable and begin producing calibrated and validated data products roughly one year after launch. Some QA activities will continue during this time, including Automatic Assessment and Routine Manual QA. In addition, Long Term QA Monitoring will be performed on a number of parameters whose values might be expected to drift with time. For example, trend analysis is the process of comparing daily granules and metadata to similar data sets from earlier in the mission. This type of analysis is used primarily

for troubleshooting during manual QA, but will also be used to track behavior of the Aqua platform, the AIRS instrument, or a PGE throughout the course of the mission.

- *Long Term QA Comparison*. All types of QA activities described above check for internal consistencies between AIRS quantities. Long Term QA Comparison will address the issue of drift between the AIRS system and the observed atmosphere since internal consistency of AIRS fields does not guarantee a reliable system. Long Term QA Comparison must therefore be made with select data sets such as operational radiosondes or dedicated ARM CART soundings. This activity merges with validation activities because it seeks to assure stability in the estimates of random and systematic errors.

#### 2.1.4. Anomaly Investigation

Anomaly Investigation is the analysis of conditions leading to anomalies as revealed by either Automatic Assessment or Routine Manual QA. Anomaly Investigation is performed at the TLSCF. If Automatic Assessment or Routine Manual QA indicate a problem, a notification is sent to the AIRS TLSCF, where the AIRS Project will determine a course of action or remedy. During Manual QA the archived logs may be used as ancillary information, along with other metadata. Identification and correction activities conducted within Anomaly Investigation are also archived for future reference.

### *2.2. Types of QA Information*

Most QA quantities are metadata defined at granule density. (A *granule* contains six minutes in time, or 45 along-track by 30 cross-track AMSU footprints. Within each AMSU footprint are nine AIRS and nine HSB footprints, and an 8 by 9 array of Vis/NIR pixels). Other quantities are defined once per scanline, or once per instrument footprint.

QA parameters at granule, scanset and footprint densities are defined in the Processing Files Description (PFD) listed with the references earlier in this document.

#### 2.2.1. High Level QA Flags for AIRS Data Users

There are three High Level QA Flags important to AIRS data users: the *OperationalQAFlag*, the *AutomaticQAFlag* and the *ScienceQualityFlag*. Each is set once per granule. They are described in detail in Chapter 4 below.

#### 2.2.2. Product-Specific Attributes

Product-Specific Attributes (PSAs) are project-specific granule-level metadata. Their primary use is as aids to ordering data from the DAAC. They are searchable. The current PSAs are defined in Appendix A. PSAs are not intended as complete granule-

level QA diagnostics, but do include those quantities expected to be relevant over the entire life of the mission (e. g. *QANumBadData*, the number of missing soundings in a granule). PSAs will be used for long term monitoring of the AIRS products.

### 2.2.3. Other Metadata

Inventory Metadata includes PSAs and generic per-granule metadata defined for all ECS products. Appendix B describes places in this and other documents where Inventory Metadata are defined, and lists a tentative set of other Inventory Metadata fields.

### 2.2.4. QA Data

Large arrays of parameters cannot practically be incorporated into metadata. Nevertheless, indicators such as AIRS calibration quality indicators will be very important during the first months of instrument operations. These are included in the data products.

# 3. Roles and Responsibilities

AIRS QA responsibilities are shared by DAAC personnel, the AIRS Project, and the data users. This section defines the responsibilities of each.

## *3.1. DAAC Responsibilities*

The DAAC has increasing responsibilities in the first years of instrument operations. These are detailed in the interface control documents (ICD) listed in the references.

After one year the DAAC will assume the responsibility of processing all AIRS data process. The DAAC responsibilities roughly one year after launch are:

- Evaluating the operational success of the data generation process.
- Investigating when the *OperationalQAFlag* is set by the system.
- Initial evaluation of PGE failures.
- For operational problems, collecting or identifying log files and granules necessary for AIRS Project to continue troubleshooting.
- Investigating quality problems reported by users via the DAAC's trouble-ticketing system and User Services, and coordinating problem resolution with the AIRS Project.
- Ensuring the integrity of the data products and metadata, i.e., that data are not corrupted in the transfer, retrieval, or archival processes.
- Supporting ECS subscription services so that AIRS Science Team personnel can order and receive granules that require additional QA.

S*ubscriptions* permit users to register their interest in changes to and events associated with data products. For example, AIRS Project personnel may register a subscription to be notified whenever a specific data product flag is set to Bad. The granule that triggered the flag will be made available to AIRS Project staff by the DAAC via ftp push to a specified remote directory at the TLSCF (based upon system functionality at the time).

## *3.2. AIRS Project Responsibilities*

The AIRS Project has responsibility for all aspect of QA during the first year after launch, at which point those activities listed above will be assumed by the DAAC. AIRS Project responsibilities for AIRS QA roughly one year after launch are:

- Ensuring the scientific integrity of AIRS data products. While granules may arrive from the DAAC with no operational errors, the AIRS Science team will evaluate them for acceptance through both qualitative and quantitative examinations.

- Investigating possible science-related problems. By determining the cause of out-of-range QA statistics, AIRS Project personnel will lay the groundwork for correcting these problems.
- Interacting with DAAC personnel. Evaluation of data products and investigation of problems will require setting subscriptions, retrieving granules from DAAC servers, and working with DAAC personnel to retrieve and understand DAAC processing logs.
- Interacting with algorithm developers from the AIRS Science Team. Evaluation of data products and investigation of problems will require discussions with the algorithm developers to understand algorithm behavior or to help the developer formulate changes to the algorithm to prevent future generation of bad data.
- Working with the instrument team and the AIRS Science Team to correct instrument-related problems.
- Reporting problems with the instruments, software and data products to the user community via the AIRS home page at http://airsteam.jpl.nasa.gov/ and through AIRS Design File Memoranda.

AIRS QA may reveal problems related to instrument behavior. Disposition of these problems is the responsibility of the AIRS Project. In addition, the AIRS Project may be able to offer advice to the instrument team in setting the instrument into its optimal operating configuration.

### *3.3. Data User Responsibilities*

Data Users are responsible for understanding how the AIRS QA flags are set by the DAAC and the AIRS Project. This information will be made available to the Data Users via the AIRS home page at http://airsteam.jpl.nasa.gov/.

# 4. High-Level AIRS QA Flags and Notification

The *OperationalQAFlag* and *AutomaticQAFlag* are set by processing software and monitored by DAAC and AIRS Project personnel, respectively. These two flags are set once per data granule. These two flags have the values of 'Passed', 'Failed' and 'Suspect'. The *ScienceQualityFlag* is tied to software version number and the release of data products. It will be reset through the processing software as part of data releases, and updated with Metadata Update Tool available from the ECS when necessary. The *ScienceQualityFlag* provides information about the overall data quality and has the values of 'Being Investigated', 'Suspect', 'Inferred Passed' and 'Passed'.

The QA Flags set by the AIRS Science Team or the DAAC are described in greater detail below.

## *4.1. QA Flags and Data Release*

The policy of the AIRS project is to release all data as soon as it is processed. This ensures that data users have timely access to the data. Released data will include the *OperationalQAFlag* and *AutomaticQAFlag*, however, and these will be set 'Bad' or 'Suspect' in some granules. It is the responsibility of the AIRS Project to publish the criteria for setting these flags. Moreover, it is imperative that users be aware that the *OperationalQAFlag* and *AutomaticQAFlag* will be set to differing values, and understand the criteria as published at the AIRS home page at http://airsteam.jpl.nasa.gov/.

Timely release of data also means that problems may be found in the data only *after* release. Data versions suspected of having problems will have their *ScienceQualityFlag* set to either 'Being Investigated' or 'Suspect' as defined below. When this occurs, problematical data will be reprocessed with updated software and released under a new version number. Any problems with already released data will be announced to the user community as soon as they as they are discovered.

## *4.2. OperationalQAFlag*

The *OperationalQAFlag* is set in response to anomalies in the processing system as part of Operational Assessment. This flag is set to 'Suspect' or 'Failed' in any granule of data if a problem is encountered in generating that granule. Data granules passing Operational Assessment are flagged as Passed. Assessing problem granules is the responsibility of the DAAC personnel. Situations triggering the *OperationalQAFlag* include:

- Failure of computer system or storage media.
- Delays in automated data delivery

Some of the conditions triggering the *OperationalQAFlag* are detailed in Chapter 2 above.

### 4.3. AutomaticQAFlag

The *AutomaticQAFlag* is set to 'Failed' or 'Suspect' if problems are encountered within the processing software, as ' Passed' otherwise. This flag is defined for each granule of data and each individual data type -- see the Processing File Descriptions listed in the Introduction. Situations leading to the setting of the *AutomaticQAFlag* include:

- Any problem indicated by the *OperationalQAFlag* that cannot be rectified by DAAC personnel.
- Crossing of thresholds in certain quantities input to a PGE.
- Floating-point exceptions.

Any *AutomaticQAFlag* trigger must have clearly defined criteria. These criteria are listed below.

### 4.4. ScienceQualityFlag

The *ScienceQualityFlag* indicates the quality of a processing software version, and is set for a large number of granules generated by that software version. The three values to be used, and associated typical ScienceQualityFlagExplanation are:

*Being Investigated* -- Products are currently being checked for internal consistencies and compared with assimilation analyses, *in situ* observations, or climatologies. Uncertainty estimates through comparisons with in situ data have not been made. See http://airsteam.jpl.nasa.gov for a discussion.

*Inferred Passed* **--** Comparisons have been made over a range of conditions, and no significant problems have been discovered. Uncertainty estimates through comparisons with correlative data are not complete. See http://airsteam.jpl.nasa.gov/ for a discussion.

*Passed* -- Data products are compared against correlative data sets under a wide range of geophysical conditions. Quantitative estimates of product uncertainties are derived from these comparisons. A product flagged 'Passed' may be considered validated, with well-specified uncertainties. See http://airsteam.jpl.nasa.gov/ for a discussion of these comparisons.

An additional value of ScienceQualityFlag may be utilized:

*Suspect* **--** Products are believed to have significant uncertainties. These uncertainties may be dependent upon meteorological or other conditions, such location on the planet. See http://airsteam.jpl.nasa.gov/ for an explanation of these conditions.

Finally, two possible ScienceQualityFlag values will not be used:

*Failed* **--** NOT A VALID FIELD FOR AIRS PRODUCTS.
*Inferred Failed* **--** NOT A VALID FIELD FOR AIRS PRODUCTS.

Note that the first three proposed valid values of the flag are roughly equivalent to the following proposed fields (Bob Lutz, June 11, 2001, personal communication) that cannot be implemented:

*Beta*, equivalent to 'Being Investigated' above -- Early release product, minimally validated and may still contain significant errors. Available to allow users to gain familiarity with data formats and parameters but not appropriate as the basis for quantitative scientific publications.

*Provisional*, equivalent to 'Inferred Passed' above -- Product quality may not be optimal and incremental product improvements are still occurring. General research community is encouraged to participate in the QA and validation of the product, but need to be aware that product validation and QA are ongoing. Users are urged to contact science team representatives prior to use of the data in publications. Provisional products may be replaced in the archive when the validated product becomes available.

*Validated,* equivalent to ' Passed' above **--** Formally validated product, although validation is still ongoing. Uncertainties are well defined, and products are ready for use in scientific publications, and by other agencies. There may be later improved versions of these products.

### *4.5. Problem Notification*

Any problems with already released data will be announced to the user community as soon as they as they are discovered. Announcements of problems with the AIRS data will be made through the publicly accessible part of the AIRS home page at http://airsteam.jpl.nasa.gov/.

## 5. AIRS QA Processes and Implementation

AIRS QA activity flow is illustrated below. This figure includes the major QA data sources and the major QA Activities.

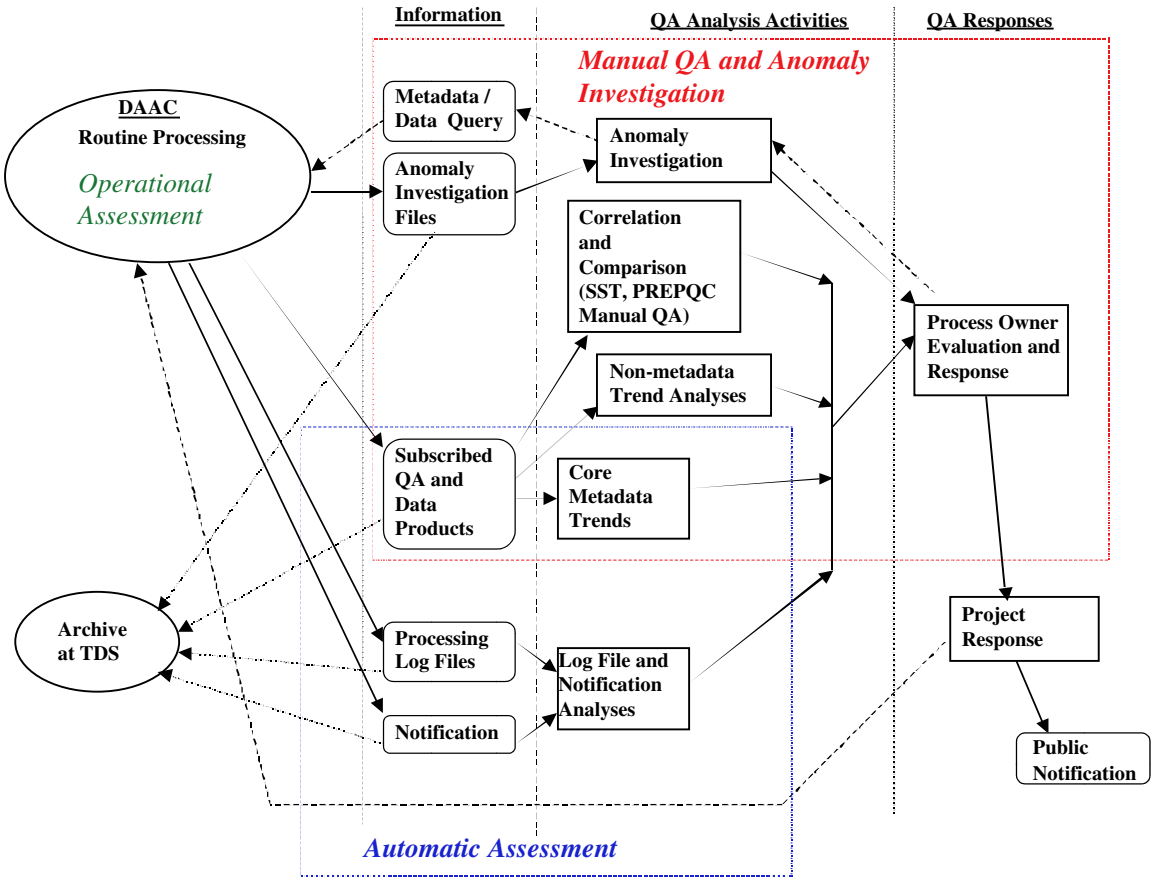


**Figure 4. Schematic of AIRS QA processing.**

QA data sources are of five types:

- Browse and Subscribed Products.
- QA Specific Products and Data
- Anomaly Investigation Files
- Processing Log Files
- Notification

The general QA activities are shown schematically in Figure 3 above.

## *5.1. PGE Name: **pgel1a_airs***

**Description**: Formats Visible and Infrared L0 science data, inserts geolocation and converts engineering telemetry from digital numbers to engineering units.

### 5.1.1. PGE Purpose and QA considerations

The primary purpose of the L1A AIRS PGE is to format the L0 science data into Hierarchical Data Format (HDF) files where the scene data, calibration data, geolocation data and engineering telemetry are easily accessible by subsequent PGEs. QA indicators are generated based on the validity and availability of the data received.

### 5.1.2. Responsibility

The AIRS Calibration Team (ACT) is responsible for the accuracy and integrity of the Level 1A data product. The process involves validation of the science data, engineering telemetry and geolocation contained within the L1A.

### 5.1.3. Output Product Files

*ESDT Shortname:* **AIRIASCI**
*File Description*: AIRS/Aqua Visible and Infrared geolocated science and calibration digital numbers. Also contains geolocation information and converted engineering telemetry (engineering units).
*Approximate File Size*: 59MB per granule

*Additional Output Files*: **AIRIACAL, AIRBAQAP, AIRIAHRE, AIRVACAL, AIRVASCI**

### 5.1.4. Automatic Assessment

The Level 1A Quality Assessment fields primarily reflect conditions with the instruments. The Level 1A QA quantities are based upon Engineering Data from the instruments, repacking indicators and geolocation.

#### *5.1.4.1 AutomaticQAFlag*

The current (placeholder) algorithm for L1A, L1B, and L2 is:

total-number-of-packets =

number-of-process-packets +

number-of-special-packets +
number-of-missing-packets +
number-of-bad-packets with good-enough-percentage

= 100.0 * (number-of-process-packets + number-of-special-packets) /
total-number-of-packets

If (good-enough-percentage < 50.0)
*AutomaticQualityFlag* = "Failed"
Else if (good-enough-percentage < 99.0)
*AutomaticQualityFlag* = "Suspect"
Else
*AutomaticQualityFlag* = "Passed"

*AutomaticQualityFlagExplanation* *always* = "Based on percentage of product that is good. Suspect used where true quality is not known."
End

AutomaticQualityFlagExplanation *always* = "Based on percentage of product that is good. Suspect used where true quality is not known."

### 5.1.5. Manual Assessment

#### *5.1.5.1 Manual Assessment of Geolocation Parameters*

Visible and infrared geolocation parameters will be analyzed for accuracy using earth scene data and programs designed to extract the geolocation from the imagery. The process is discussed in section 6.3 of the AIRS Visible and Infrared In-flight Calibration Plan. We give a brief description below.

The latitude and longitude of each inflection point are determined by linear interpolation between the adjacent data points. To reduce extraneous data due to the rapidly changing thermal contrast of inland terrain, only data predicted to be within 25 km of the coastline is processed. Latitude and longitude errors are determined for each scene by minimizing the least squares distance of the ensemble of crossings to the coastline map. These errors are transformed into in-scan and cross-scan errors for correlation with possible instrument error sources. In-scan and cross-scan location errors will be determined by averaging individual scene samples collected over extended time periods.

#### *5.1.5.2 Manual Assessment Engineering Telemetry*

Engineering Telemetry is provided in the AIRIAHRE product. This file provides all of the engineering telemetry for every scan of AIRS. The data are processed for statistics

(max, min, mean, etc) by the L1B high rate engineering telemetry. It is in the evaluation of these statistics that the L1A telemetry will be evaluated.

The process involves comparing the statistics obtained in orbit with those obtained pre-launch. Finally trending of the engineering telemetry over the course of the mission will allow frequent assessment of the integrity of the data as well as the health and safety of the instrument. More details are provided in section 5 of the AIRS Visible and Infrared In-Flight Calibration Plan.

## *5.2. PGE Name:* ***pgel1b_airs***

**Description**: Converts Infrared L1A detector counts to Calibrated Radiances.

### 5.2.1. PGE Purpose and QA Considerations

The primary purpose of the L1B AIRS PGE is to produce calibrated infrared radiances. The process involves application of on-board calibration data and pre-flight tables to the digital numbers measured from all the IR channels. QA indicators also generated by the L1B AIRS PGE allow trending of the offsets, gains, noise and critical telemetry used in the conversion.

### 5.2.2. Responsibility

The AIRS Calibration Team (ACT) is responsible for the accuracy and integrity of the Level 1B Infrared data product. The process involves routine automatic and manual QA of the AIRS Level 1B data stream combined with periodic testing of the AIRS during the in-orbit operations. The process is outlined here; additional detail is provided in the AIRS Visible and Infrared In-Flight Calibration Plan.

### *5.2.3.* Output Product Files

*ESDT Shortname:* **AIRIBRAD**
*File Description*: AIRS/Aqua Infrared geolocated radiances in 2378 spectral channels ranging from 3.7-15.4 microns with IFOV of approximately 1.1 degree along-track and 0.6 degrees cross-track ±49.5°.
*Approximate File Size*: 130MB per granule

*Additional Output Files*: **AIRIBCBS, AIRIBQAP**

### 5.2.4. Automatic Assessment

These provide a measure of numerous performance characteristics such as the instrument gain, spectral centroids, noise, and temperatures. A complete listing of the AIRS L1B QA indicators is provided in Appendix A1-9 of the PFD, the L1B AIRS QA Interface Specification. Detailed definitions for the QA indicators is provided in "Atmospheric Infrared Sounder (AIRS) Level 1B Visible, Infrared and Telemetry Algorithms and Quality Assessment (QA) Processing Requirements" listed in the references.

Statistics are calculated on these parameters mostly once per granule, but several QA indicators including noise events are provided once per scan.

#### *5.2.4.1 AutomaticQAFlag*

The *AutomaticQAFlag* is based on the fraction of good data in the granule and not on the calibration flags. The fraction of good data in the granule is defined as

$$F = (NumProcessData + NumSpecialData) / NumTotalData$$

The AutomaticQAFlag =

"Passed" if $F \geq 0.99$ or Bits 0-7 in *CalGranSummary* = 0;

"Suspect" if $0.99 > F \geq 0.5$ or Any of Bits 0-4 and 7 in *CalGranSummary* = 1;

"Failed" if $F < 0.5$ or Either Bits 5 or 6 in *CalGranSummary* = 1;

*CalGranSummary* is defined below.

#### *5.2.4.2 Calibration QA Flags*

In addition to the *AutomaticQAFlag*, calibration flags have been embedded in the L1B data product to alert users of the L1B data product of potential calibration issues. The calibration flags provide a bit-wise summary of the quality of the calibration over the spatial and spectral extent identified. The details are listed in A1-9, and the names of these parameters are:

| | |
|---|---|
| *CalGranSummary*: | over all channels per granule |
| *CalChanSummary*: | by channel per granule |
| *CalScanSummary*: | over all channels per scanline |
| *CalFlag*: | by channel per scanline |
| *SceneInhomogeneous*: | over all channels per footprint |

### 5.2.5. Manual Assessment

#### *5.2.5.1 Routine Monitoring*

The L1B QA indicators are processed on a regular basis for trending of the instrument performance. For example, the instrument gain is tracked on a regular basis to monitor for potential contamination or icing of the optical system. This activity will be performed daily for most critical parameters, with some parameters monitored on longer time-scales. The processing of L1B QA indicators will be done with software that is not a part of the PGS. Later (after one to two years) the processing may become part of the routine automatic QA processing of the PGS. Table 1 gives the parameters to be examined as part of the routine monitoring of QA. A complete description of the deliverables and techniques see the AIRS VIS and IR In-Flight Calibration Plan.

| Cal Plan Section | Product Description | Deliverables examined |
|---|---|---|
| 4.2.1 | Science Data and Radiances | Science Counts Limit Detection |
| 4.2.5 | | Radiance Statistics |
| 4.2.1 | Space View Offset and DCR | Space Counts Limit Detection |
| | | Drift Analysis |
| | | Space View Uniformity Amongst 4 Views |
| | | Space View Uniformity vs. Orbit |
| | | Non-Gaussian Noise Detection |
| 4.2.2 | Radiometric Offset (Pol) | Scan Angle Dependence |
| | | Orbital Dependence |
| 4.2.3 | OBC Blackbody Telemetry | Temperature Sensor Analysis |
| 4.2.4 | Gain Tracking | Image Evaluation of Gains |
| | | Scan Line Dependence (Short Term) |
| | | Orbital Dependence |
| | | Daily Variation |
| | | Annual Variation |
| | | Saturation Detection |
| 4.2.5 | Noise Monitoring | Daily Variation |
| | | Orbital Dependence |
| | | Annual Variation |
| | | Out-of-Limit Detection |
| 4.3.1 | Reference Spectrum | Climatology Selection |
| 4.3.2 | Cloud-free Feature ID | Feature Contrast Analysis |
| 4.3.3 | Upwelling Feature Fitting | Modality |
| | | Daily Variation |
| | | Orbital Dependence |
| | | Mission Variation |
| | | Covariance |
| | | Climatology Dependence |
| 4.3.4 | OBS (Parylene) Feature Fitting | Modality |
| | | Daily Variation |
| | | Orbital Dependence |
| | | Drift Analysis |
| 4.3.5 | Focal Plane Fitting | Daily Variation |
| | (Offset and $\Delta$EFL) | Daily Summary |
| | | Drift Analysis |
| | | Orbital Dependence |
| | | Feature Residuals |
| 4.3.6 | Channel Spectra Determination | Entrance Filter Temp Limits |
| 4.4. | Spatial Uniformity | Scan Angle Dependence |
| | | Scene Type Dependence |
| | | Instrument Dependence |

**Table 1. Products included in routine monitoring of Level1B infrared QA.**

#### *5.2.5.2 Engineering Telemetry Monitoring*

Monitoring of the complete set of AIRS engineering telemetry data is part of the QA plan for AIRS. AIRS produces a L1B engineering telemetry data product that provides granule level statistics and limit checking on all the engineering data. This will be tracked and trended at the TLSCF for the first year. The results of this effort will provide a long-term trending assessment in support of instrument operations.

#### *5.2.5.3 Anomaly Investigation*

Monitoring of the complete set of AIRS engineering telemetry data is part of the QA plan for AIRS. AIRS produces a L1B engineering telemetry data product that provides granule level statistics and limit checking on all the engineering data. This will be tracked and trended at the TLSCF for the first year. The results of this effort will provide a long-term trending assessment in support of instrument operations.

### 5.2.6. Setting the ScienceQualityFlag

All L1b IR data will be flagged as "Being Investigated" until the AIRS Calibration Team completes its initial assessment of the quality. At their directive, the *ScienceQualityFlag* will be improved to "Inferred Passed" (this is expected to occur within the first 6 months of instrument operations). After review by the AIRS Science Team, and upon their directive, the L1b data will be flagged as "Passed" (expected 1 year after launch).

### 5.2.7. Product-Specific Attributes

In addition to the set of PSAs common to all products (Appendix A table 5), the *CalGranSummary* word as defined in "Atmospheric Infrared Sounder (AIRS) Level 1B Visible, Infrared and Telemetry Algorithms and Quality Assessment (QA) Processing Requirements" (see references in Introduction) is included as an AIRS IR L1B PSA. This enables us to query the database on the specific attributes of the calibration as contained in the CalGranSummary. Each bit of the CalGranSummary word identifies whether or not an out-of-limit condition was encountered in the granule for certain critical performance indicators.

### 5.2.8. Other Level 1B IR QA Techniques

**Special Testing.** A complete set of special tests has been developed to track the AIRS performance throughout the mission life. These tests were initially performed at the instrument development contractor's facility and will be performed again at the spacecraft facility and in orbit during the checkout phase and periodically throughout the

life of the mission. The tests ensure the stability and accuracy of the calibration throughout the mission.

**Earth Scene Verification**. Radiometric calibration will be confirmed by comparison with forward radiance calculations in the window channels using buoy-observed sea surface temperatures as a lower boundary condition. This check will be particularly useful during the first few months after launch. After this point, the effort transitions to the validation program. The AIRS spectral calibration is dependent on the upwelling features and their associated properties. The ACT will refine the list of features through routine monitoring of the upwelling radiance for spectral information. Finally, ACT will perform geolocation of the L1B radiances by evaluation of coastal crossings. The ACT Earth Scene Verification program will ultimately provide updates to the calibration tables used in the L1B data processing. This effort is critical since it provides a check of the calibration using external sources, while in some cases providing the necessary calibration parameters to run the L1B PGE.

**Reporting**. Results of special calibration testing and Earth scene verification will be posted on the web in the form of AIRS design file memoranda. Coefficients for calibration will be updated and incorporated into the latest version of the L1B PGE.

## *5.3. PGE Names*: ***pgel1b_amsu, pgel1b_hsb***

**Description**: Generate calibrated microwave radiances form instrument counts.

### 5.3.1. PGE Purpose and QA considerations

The primary purpose of the Microwave Level 1B is to compute calibration coefficients and use those to generate calibrated brightness temperatures. There are two versions of the microwave L1b files, distinguished by the scope of QA parameters included. A minimal set of QA parameters is produced for routine monitoring. A full set of parameters is produced for detailed diagnostics and Anomaly Investigation

### 5.3.2. Responsibility

AIRS Project and AIRS Science Team.

### 5.3.3. Output Product File

*ESDT Shortname*: **AIRABRAD, AIRABQAP, AIRABPAR**
*File Description*: There are two versions of the AMSU-A L1b product file. One version (AIRABRAD) contains a minimal set of QA parameters, while the other version (AIRABQAP) contains a full set of QA parameters. Both versions include geolocated calibrated radiances and associated parameters, as well as the calibration coefficients (AIRABPAR).
*File Size*: 0.3 Mbytes per granule (AIRABRAD + AIRABPAR);
0.4 Mbytes per granule (AIRABQAP + AIRABPAR)

*ESDT Shortname*: **AIRHBRAD, AIRHBQAP, AIRHBPAR**
*File Description*: There are two versions of the HSB L1b product file. One version (AIRHBRAD) contains a minimal set of QA parameters, while the other version (AIRHBQAP) contains a full set of QA parameters. Both versions include geolocated calibrated radiances and associated parameters, as well as the calibration coefficients (AIRHBPAR).
*File Size*: 1.4 Mbytes per granule (AIRHBRAD + AIRHBPAR);
1.7 Mbytes per granule (AIRHBQAP + AIRHBPAR)

### 5.3.4. Automatic Assessment

Many QA parameters are defined to reveal problems with the calibration process. The minimal QA set is listed in the tables at the end of this section.

#### 5.3.4.1 AutomaticQAFlag

The Level 1b *AutomaticQAFlag* is set to 'Suspect' if:

- The input L1a QA flag is 'Suspect'.
- "Number of scan lines with calibration problems" is not zero.
- "Number of scan lines with significant coast contamination" is not zero.
- "Number of scan lines with significant sun glint" is not zero.
- Number of scan lines with "Excessive NEDT estimated" is not zero

The Level 1b *AutomaticQAFlag* is set to 'Failed' if:

- The input L1a QA flag is 'Failed'.
- "Number of calibrated scan lines in this granule" is zero.

The *AutomaticQAFlag* is otherwise set to "Passed".

### 5.3.5. Manual Assessment and Routine Monitoring

The primary method for assessing the performance and quality of microwave calibration and other L1b processes is to monitor trends and analyze statistical summaries of the QA parameters contained in the concise set. They fall into four categories:

1) Data quantity indicators

   These can be used to detect problems with the data streams as well as the overall processing system and can be used by the end user to select complete data sets. We will keep statistical summaries of these parameters and will use those to detect trends or transients in data gaps and related measures.

2) Calibration quality indicators

   These parameters, which include estimates of radiometric noise, gross indicators of calibration problems as well as the values of the radiometric calibration coefficients, will be monitored on daily to monthly time scales. Long-term trend analysis will also be done, which will be used to detect changes in the instruments.

3) Calibration diagnostic indicators

   Statistical indicators and trends will also be kept for these parameters, but they will be analyzed only when gross indicators show that there are problems and to produce monthly summary reports. Some of these parameters are detailed, per-scanline indicators.

4) Radiometric quality monitoring

This category consists of monitoring the radiances (brightness temperatures), i.e. the primary output of the L1b process. Since the radiances are highly variable and depend on the geophysical conditions, we have not attempted to define relevant QA parameters, per se. Instead, the quality of the radiances will be monitored directly. This will consist of both short term monitoring of single-swath data and long-term monitoring of averages. Tools include 2-D color plots of swath data as well as cross-track and along-track line plots. Long-term averages will be used to detect orbital and seasonal periodicities as well as trends. They will also be used to detect scan angle biases, swath asymmetries and other biases. This type of monitoring will be done on an ongoing basis. In addition, we will also use both model (and other "truth" data) and the AIRS retrievals to estimate expected radiances and compute residuals, which will be analyzed for problems at all time scales.

#### *5.3.5.1 Anomaly Investigation*

Automatic Assessment or Routine Monitoring will reveal problems leading to Anomaly Investigation. Given the complexity of the algorithms, the nature of any on-orbit Anomaly Investigation cannot be foreseen.

#### *5.3.5.2 Anomaly Investigation*

Whenever anomalous behavior is detected (either by tripping of the *AutomaticQAFlag*, routine monitoring, or serendipitous discovery), a detailed investigation will ensue. As this is a highly interactive and variable process, it cannot be described in detail, but it is likely that a review of all parameters discussed in Section 5.x.7 will ensue, until an explanation is found.

### 5.3.6. Setting the *ScienceQualityFlag*

All AMSU-A and HSB level 1b data will be flagged as "Being Investigated" until the AIRS Microwave Instrument Scientist completes his initial assessment of the quality. At the directive of the AIRS Project Manager, the *ScienceQualityFlag* will be improved to "Inferred Passed" (this is expected to occur within the first 2 months of instrument operations). After review by the AIRS Science Team, and upon their directive, the L1b data will be flagged as "Passed" (expected 3-6 months after launch).

### 5.3.7. Relevant QA Metadata and Parameters

#### *5.3.7.1 Product-Specific Attributes*

The following PSAs are relevant to the Level 1B microwave products:

*NumMoonInViewMW* The number of scanlines in granule with the moon in the microwave space view.

Note also that the PSAs *NumClearMW, NumCloudIceMW, NumBadL1BAMSU*, and *NumBadL1BHSB* are set in the Level 2 software but may be of interest to users of the Level 1B microwave products.

#### *5.3.7.2 Other QA Metadata and Parameters*

The parameters described below are currently implemented in the microwave Level 1B PGE, and listed in the associated PFD.

| Parameter | #AMSU | #HSB | Type |
|---|---|---|---|
| Number of scan lines in this granule | 1 | 1 | Int |
| Number of scan lines in this granule not in normal scan mode | 2 | 1 | Int |
| Number of calibrated scan lines in this granule | 3 | 1 | Int |
| Number of missing scan lines in this granule | 2 | 1 | Int |
| Number of data gaps in this granule | 2 | 1 | Int |
| Number of instrument mode changes in this granule | 2 | 1 | Int |
| Number of scan lines with calibration problems – per receiver | 3 | 1 | Int |
| Number of scan lines with calibration problems – per channel | 15 | 4 | Int |
| Number of scan lines with significant coast contamination | 1 | 1 | Int |
| Number of scan lines with significant sun glint | 1 | 1 | Int |
| Radiometer scene count statistics for this granule | 30x15 | 90x4 | UES |
| Radiometer calibration count statistics for this granule | 2x15 | 2x4 | UES |
| Blackbody temperature statistics for this granule (all PRTs) | 3 | 1 | LES |
| Receiver temperature statistics for this granule (all PRTs) | 3 | 1 | LES |
| Calibration coefficient statistics for this granule | 15x3 | 4x3 | UES |
| Blackbody “raw” noise count statistics for this granule | 15 | 4 | UES |
| Space view “raw” noise count statistics for this granule | 15 | 4 | UES |
| NEDT estimate statistics for this granule | 15 | 4 | UES |
| Ratio of NEDT-est. to NEDT-nom. statistics for this granule | 15 | 4 | UES |

**Table 2 Per-granule microwave QA parameters.**

| Parameter | #AMSU | #HSB | Type |
|---|---|---|---|
| Some channels were not calibrated | 3 | 1 | Bit |
| Calibrated, but there was a data gap | 3 | 1 | Bit |
| Calibrated, but some PRT values were bad or marginal | 3 | 1 | Bit |
| Calibrated, but there was a blackbody scan position error | 3 | 1 | Bit |
| Calibrated, but there was a space view scan position error | 3 | 1 | Bit |
| Calibrated, but the moon was in the space view | 3 | 1 | Bit |
| Not calibrated, due to bad or missing PRT values | 3 | 1 | Bit |
| Not calibrated, due to the instrument mode | 3 | 1 | Bit |

**Table 3 Per-scanline calibration summary (per receiver).**

| Parameter | #AMSU | #HSB | Type |
|---|---|---|---|
| Excessive NEDT estimated | 15 | 4 | Bit |
| Most recent calibration coefficients used | 15 | 4 | Bit |
| Blackbody counts could not be smoothed | 15 | 4 | Bit |
| Blackbody counts marginal for this channel and scan line | 15 | 4 | Bit |
| All blackbody counts were bad for this channel and scan line | 15 | 4 | Bit |
| Space view counts could not be smoothed | 15 | 4 | Bit |
| Space view counts marginal for this channel and scan line | 15 | 4 | Bit |
| All space view counts were bad for this channel and scan line | 15 | 4 | Bit |

**Table 4 Per-scanline calibration quality (per channel).**

| Parameter | #AMSU | #HSB | Type |
|---|---|---|---|
| Near sidelobe correction applied | 1 | 1 | Bit |
| Some channels had excessive NEDT estimate | 1 | 1 | Bit |
| Coastal contamination in this scan line | 1 | 1 | Bit |
| Sun glint in this scan line | 1 | 1 | Bit |

**Table 5 Other per-scanline QA indicators.**

## *5.4. PGE Name: **pgel1b_vis***

**Description**: Converts Visible / Near-IR Level 1A detector counts to Calibrated Visible / Near-IR Radiances

### 5.4.1. PGE Purpose and QA considerations

The primary purpose of this PGE is to produce Vis / NIR calibrated radiances. The reported error on these radiances will reflect our best estimate of the overall quality of the process that produces this product. Metadata defined in later sections provides quality information down to the pixel level.

### 5.4.2. Responsibility

AIRS Project and AIRS Science Team.

### 5.4.3. Output Product File

*ESDT Shortname*: **AIRVBRAD**
*File Description*: AIRS / Aqua VIS/NIR geolocated radiances in four wavelength bands (centers near 0.4, 0.6, 0.8 microns, plus a broad-band channel), with IFOV (pixel size) being approximately 0.185 deg across track and 0.148 degrees along track (2.3 by 1.8 km at nadir).
*File Size*: 17.5 MB per granule.

### 5.4.4. Automatic Assessment

Automatic assessment of the L1b data quality is based on various limit checks and the timeliness of calibration information. The relevant parameters, reported in the data product, are:

- *limit_scene_counts* Reports scene data out of the expected range.
- *limit_bb_counts* Reports blackbody (dark-current) data out of the expected range.
- *limit_phot_counts* Reports calibration lamp data out of the expected range.
- *limit_vis_det_temp* Reports detector temperatures out of the expected range.
- *gain_TAI* and *gain_TAI_prev* These indicate the most recently available instrument gain calculation.

#### *5.4.4.1 AutomaticQAFlag*

The *AutomaticQAFlag* for the Vis/NIR products is set to “Failed” when either of these two conditions is satisfied:

- *gain_TAI* is 0 and all elements of *gain_TAI_prev* are more than 3.5 hours prior to the granule start time. (This will flag a granule whose calibration is more than 3.5 hours old.)
- More than 1% of the footprints within the granule have exceeded one or more of the above limits (scene counts, blackbody counts, lamp counts, or detector temperature), excluding scene data whose sun glint distance is less than 50 km. (This flags a granule whose data are grossly out of bounds.)

Otherwise, the *AutomaticQAFlag* is set to "Passed". As operational experience with the instrument is developed, the above conditions are likely to be revised, and a third flag setting ("Suspect") will be introduced.

### 5.4.5. Manual Assessment

Manual assessment of data quality will be done for two purposes: monitoring to confirm our understanding of how the instrument and its automatic assessment algorithms are performing (including trend analysis), and investigations of anomalous behavior. Each is described in more detail below.

#### *5.4.5.1 Routine Monitoring*

The most critical routine monitoring is periodic vicarious calibration of the Vis/NIR radiances against known ground targets, and cross-calibration with the MODIS instrument. These activities are described in detail in the Vis/NIR L1b ATBD, and are expected to be carried out approximately every 6 months by the AIRS Science Team. The results of these external calibrations will be reflected in the reported error bars on L1b radiances, and in the "G" and "M" parameters within the file.

In addition to the above monitoring, the AIRS Project has responsibility for trend analysis of various parameters. Section 5.4.7 has a complete list, but at this time the most crucial are expected to be:

- Gain and offset terms calculated from on-board sources.
- Calibration lamp ratios (K-factors).
- External calibration parameters (G and M terms).
- Number of pixels exceeding limit checks.
- Radiance error estimate.

#### *5.4.5.2 Anomaly Investigation*

Whenever anomalous behavior is detected (either by tripping of the *AutomaticQAFlag*, routine monitoring, or serendipitous discovery), a detailed investigation will ensue. As this is a highly interactive and variable process, it cannot be described in detail, but it is

likely that a review of all parameters discussed in Section 5.4.7 will ensue, until an explanation is found.

#### *5.4.5.3 Anomaly Investigation*

Whenever anomalous behavior is detected (either by tripping of the *AutomaticQAFlag*, routine monitoring, or serendipitous discovery), a detailed investigation will ensue. As this is a highly interactive and variable process, it cannot be described in detail, but it is likely that a review of all parameters discussed in Section 5.4.7 will ensue, until an explanation is found.

### 5.4.6. Setting the *ScienceQualityFlag*

All L1b Vis/NIR data will be flagged as "Being Investigated" until the AIRS Calibration Team completes its initial assessment of the quality. At their directive, the *ScienceQualityFlag* will be improved to "Inferred Passed" (this is expected to occur within the first 6 months of instrument operations). After early validation activities are completed by the AIRS Science Team, and upon their directive, the L1b data will be flagged as "Passed" (expected 1 year after launch).

### 5.4.7. Relevant QA Metadata and Parameters

#### *5.4.7.1 Product-Specific Attributes*

The output of the Vis/NIR L1b PGE has the following PSA's, which are searchable parameters. They were chosen to provide information on the performance of the PGE and the presence of clouds within the data even when a user does not have the data file.

*VISDarkAMSUFOVCount* This reports the number of AMSU-A footprints in the granule appearing uniformly dark in the visible, and are therefore likely to be clear.

*VISBrightAMSUFOVCount* This reports the number of AMSU-A footprints in the granule appearing uniformly bright in the visible, and are therefore likely to be cloudy.

*NumBadL1BVIS* Number of AMSU-A footprints in the granule for which either the on-board gain calibration is more than 3.5 hours old, or which exceed the nominal limits as described in section 5.4.4.1.

#### *5.4.7.2 Other QA Metadata and Parameters*

The L1B product file itself contains many parameters useful in quality assessment at the granule, AMSU-A, IR, and even Vis/NIR pixel resolution. The following are expected to be the most relevant. See the PFD for a detailed description of each:

*align_1_2_maxang*
*align_1_2_nadir*
*align_2_3_maxang*
*align_2_3_nadir*
*align_2_4_maxang*
*align_2_4_nadir*
*align_vis_airs*
*bright_index*
*bulb_failed*
*ftptgeoqa*
*gain*
*gain_err*
*gain_fit_dev*
*gamma_ground*
*gamma_MODIS*
*glintgeoqa*
*inhomo_index*
*input_bb_counts*
*input_phot_counts*
*input_scene_counts*
*input_vis_det_temp*
*K_factors_applied*
*K21*
*K31*
*K32*
*limit_offsets*
*Num_fpe*
*NumBadData*
*NumMissingData*
*NumProcessData*
*NumSpecialData*
*offset*
*offset_err*
*offset_fit_dev*
*offset_stats*
*offset_unc_stats*
*rad_stats*
*rad_unc*
*rad_unc_stats*
*satgeoqa*
*ScHeadTemp1*
*sun_glint_distance*
*track_err*
*VegMapDate*
*ViSnsrArrTemp*
*xtrack_err*
*zengeoqa*

## 5.5. PGE Name: ***pgel2***

**Description**: Retrieves geophysical quantities from observed radiances

### 5.5.1. PGE Purpose and QA considerations

The primary purpose of this PGE is to retrieve temperature, cloud, moisture and surface properties from calibrated radiances. All retrieved quantities also have associated uncertainty estimates. Many Level 2 QA parameters are defined at the basic data granularity of an AMSU footprint.

### 5.5.2. Responsibility

AIRS Project and AIRS Science Team

### 5.5.3. Output Product Files

*ESDT Shortname*: **AIR2XRET**
*File Description*: This is the standard output file for AIRS level 2 products. This contains the AIRS standard level 2 products and ancillary data. The profiles are at 28 pressure levels defined by the AIRS project.
*File Size*: 4.6 Mbytes per six-minute granule.

*ESDT Shortname*: **AIRX2SUP**
*File Description*: This is the support product for AIRS level 2 products. This has profile data at higher vertical resolution (100 pressure levels), research products, as well as the intermediate products needed for the retrieval of the standard products. The vertical resolution in the support file is the same as pressure levels used in the AIRS rapid transmittance algorithm. This file complements the standard product file.
*File Size*: 14.3 Mbytes per granule.

*ESDT Shortname*: **AIRI2CCF**
*File Description*: This is the cloud cleared radiance output from AIRS level 2 PGE. This contains the cloud cleared radiances, the radiances AIRS would have observed if there were no cloud in the field of view. This product is at the spatial resolution of AMSU.
*File Size*: 14.3 Mbytes per granule.

*ESDT Shortname*: **AIRX2RBS**
*File Description*: This is the browse subset file for the level 2 products. The primary purpose of this file is to generate the level 2 browse products. This file will also be used in the validation of AIRS products
*File Size*: 0.1 Mbytes per granule.

*ESDT Shortname*: **AIRI2CBS**
*File Description*: This is the browse subset file for the cloud cleared radiance products. This file is used in the generation of the cloud cleared radiance browse products.
*File Size*: 0.1 Mbytes per granule.

### 5.5.4. Automatic Assessment

Many QA parameters are defined to reveal problems with the retrieval software. These are listed and described in the Processing Files Description listed in the Introduction to this document. Most of these quantities are found in AIRX2SUP, the Level 2 Support Products.

#### *5.5.4.1 AutomaticQAFlag*

The Level 2 *AutomaticQAFlag* is 'Failed' under the following conditions:

- AMSU Level 1B *AutomaticQAFlag* is 'Missing'.
- AMSU Level 1B *AutomaticQAFlag* is 'Failed'.

The Level 2 *AutomaticQAFlag* is 'Suspect' under the following conditions:

- AMSU Level 1B *AutomaticQAFlag* is 'Suspect'.
- HSB Level 1B *AutomaticQAFlag* is 'Missing', 'Suspect', or 'Failed'.
- AIRS Level 1B *AutomaticQAFlag* is 'Missing', 'Suspect', or 'Failed'.
- AVN Forecast *AutomaticQAFlag* is 'Missing', 'Suspect', or 'Failed'.
- Tuning *AutomaticQAFlag* is 'Missing', 'Suspect', or 'Failed'.
- Sustained significant increase in the percentage of rejected retrievals.
- Significant changes in tuning coefficients.
- Significant increase in floating point errors.

The Level 2 *AutomaticQAFlag* is otherwise 'Passed'.

### 5.5.5. Manual Assessment

Manual assessment of data quality will be done for two purposes: monitoring to confirm our understanding of how the instrument and its automatic assessment algorithms are performing (including trend analysis), and investigations of anomalous behavior. Each is described in more detail below.

#### 5.5.5.1 Routine Monitoring

The most critical routine monitoring of level 2 products is routine monitoring of retrieval statistics against radiosondes. We will compute the daily statistics of retrievals against the operational radiosonde network. The input file used will be the routine radiosonde matchup file. The trend of tuning coefficients and the rejection rates will be routinely monitored as well.

#### 5.5.5.2 Anomaly Investigation

Whenever anomalous behavior is detected (either by tripping of the *AutomaticQAFlag*, routine monitoring, or serendipitous discovery), a detailed investigation will ensue. As this is a highly interactive and variable process, it cannot be described in detail, but it is likely that a review of all parameters discussed in Section 5.x.7 will ensue, until an explanation is found.

#### 5.5.5.3 Anomaly Investigation

Automatic Assessment or Routine Monitoring will reveal problems leading to Anomaly Investigation. Given the complexity of the Level 2 algorithms, the nature of any on-orbit Anomaly Investigation cannot be foreseen.

### 5.5.6. Setting the *ScienceQualityFlag*

All AIRS level 2 data will be flagged as "Being Investigated" until the AIRS Validation Team completes its initial assessment of the quality. At their directive, the *ScienceQualityFlag* will be improved to "Inferred Passed" (this is expected to occur within the first 7 months of instrument operations). After review by the AIRS Science Team, and upon their directive, the L2 data will be flagged as "Passed" (expected 1 year after launch).

### 5.5.7. Relevant QA Metadata and Parameters

#### 5.5.7.1 Product-Specific Attributes

The output of the AIRS Level 2 PGE has the following PSAs, which are searchable parameters. They were chosen to provide information on the performance of the PGE.

| | |
|---|---|
| *VersionRetrieval* | The version of the level 2 PGE software |

| | |
|---|---|
| *NumBadL1B* | The number of AMSU footprints with invalid level 1b data |
| *NumBadL1BAIRS* | The number of AMSU footprints with at least 5 footprints with valid AIRS level 1b data |
| *NumBadL1BAMSU* | The number of AMSU footprints with invalid AMSU level 1b data |
| *NumBadL1BHSB* | The number of AMSU footprints with at least 5 footprints with valid HSB level 1b data |
| *NumBadL1BVIS* | The number of AMSU footprints with invalid VIS level 1b data |
| *NumNoPsurfGuess* | The number of AMSU footprints where the surface guess was not obtained from numerical weather forecast. |
| *NumNoTuning* | The number of AMSU footprints where the tuning correction was not made. |
| *NumNoAngCorr* | The number of AMSU footprints where the angle adjustment was not performed. |
| *NumFpe* | The number of AMSU footprints where the floating point exception occurred. These footprints were rejected. |
| *NumPrecipMW* | The number of AMSU footprints where MW only retrieval detected precipitation |
| *NumCloudIceMW* | The number of AMSU footprints where MW only algorithm detected cloud ice |
| *NumClearMW* | The number of AMSU footprints where MW algorithm detect no ice/liquid cloud. |
| *NumClearIR* | The number of AMSU footprints where the combined MW/IR/Vis algorithm found no cloud. |
| *NumMWStratIrRetOnly* | The number of AMSU footprints where MW channels and only the stratospheric IR channels were used in the retrieval. |

#### *5.5.7.2 Other QA Metadata and Parameters*

See the PFD for a detailed description of the Level 2 QA parameters.

## *5.6. PGE Name:* ***pgebr_hsb, pgebr_amsu, pgebr_airs, pgebr_l2_d, pgebr_l2_cc***

**Description**: Converts physical quantities to pixel values, produces gridded raster images.

### 5.6.1. PGE Purpose and QA considerations

The primary purpose of these PGEs is to produce gridded global 8-bit raster images from AIRS, AMSU and HSB data files at a spatial resolution of $1^{o}$x$1^{o}$ degree. The browse image products will be used for data ordering through the EDG and for manual QA at the TLSCF. There are no QA parameters that are unique to the browse products. They will contain the Core Metadata of the associated AIRS/AMSU/HSB products.

The Browse Products and the subset data fields used to generate them are data that are used for Manual QA at the TLSCF of the Level 1B and Level 2 products.

### 5.6.2. Responsibility

AIRS Project and AIRS Science Team

### 5.6.3. Output Product Files

*ESDT Shortname*: **AIRHBDBR**
*File Description*: HSB Daily Browse (one for ascending and one for descending with the same LID). Raster images of brightness temperatures for HSB Channels 2, 3, 4, and 5. Channel 1 is not used.
*File Size*: 292 KB

*ESDT Shortname*: **AIRABDBR**
*File Description*: AMSU Daily Browse (one for ascending and one for descending with the same LID). Raster images of brightness temperatures for AMSU Channels 1, 2, 3, , 4, 5, 6, 7, and 15.
*File Size*: 567 KB

*ESDT Shortname*: **AIRIBDBR**
*File Description*: AIRS Daily Browse (one for ascending and one for descending with the same LID). Raster images of radiances converted to brightness temperatures for 5 AIRS channels: AIRS temperature sensing channel (200 mb), ozone sensing channel, window channel, methane channel, water vapor sensing channel.
*File Size*: 397 KB

*ESDT Shortname*: **AIRX2ASD**
*File Description*: Daily summary statistics for AIRS Level 2 subset parameters. The Level 2 daily summary statistics file is in HDF-EOS grid format and consists of $1^{o}$x$1^{o}$ arrays of floating point quantities for a subset of AIRS Level 2 retrieved standard products. Quantities include mean, min, max, median and standard deviation of Level 2 retrieval parameters: cloud percent (combined), retrieved skin surface temperature, water vapor burden, ozone burden, microwave first guess total water and microwave rain rate.
*File Size*: 991 KB

*ESDT Shortname*: **AIRX2DBR**
*File Description*: Level 2 Retrieval Daily Browse (one for ascending and one for descending with the same LID). Raster images of a subset of AIRS Level 2 retrieved standard products. Quantities include: cloud percent (combined layers), retrieved skin surface temperature, water vapor burden, ozone burden, microwave first guess total water and microwave rain rate.
*File Size*: 595 KB

*ESDT Shortname*: **AIRI2DBR**
*File Description*: Level 2 Cloud Cleared Radiances Daily Browse (one for ascending and one for descending with the same LID). Raster images of radiances converted to brightness temperatures for 5 AIRS channels: AIRS temperature sensing channel (200 mb), ozone sensing channel, window channel, methane channel, water vapor sensing channel.
*File Size*: 397 KB

### 5.6.4. Automatic Assessment

Automatic assessment of the Browse data quality is based on limit checks for microwave Level 1B quantities, checking of missing and bad data flags and checking of some QA parameters for Level 2 quantities.

#### *5.6.4.1 AutomaticQAFlag*

No QA flags will be set during browse processing.

### 5.6.5. Manual Assessment

Manual assessment of data quality will be done to confirm that the gridding algorithm and software are performing correctly.

#### 5.6.5.1 Routine Monitoring

None planned.

#### 5.6.5.2 Anomaly Investigation

Whenever anomalous results are detected an investigation into the cause will ensue. As this is a highly interactive and variable process, it cannot be described in detail.

### 5.6.6. Setting the *ScienceQualityFlag*

The *ScienceQualityFlag* is not relevant to Browse products.

### 5.6.7. Relevant QA Metadata and Parameters

During generation of Level 2 subset files within the Level 2 PGE, the following footprint level QA parameters are checked:

*bad_o3*
*bad_vis_cld_det*
*bad_vis_var*

If a checked QA parameter is set, then the data value is set to missing in the Level 2 subset files and is not used for browse product generation.

#### 5.6.7.1 Product-Specific Attributes

The output of the Daily Browse PGEs will contain the Core Metadata of the associated AIRS/AMSU/HSB products.

#### 5.7.7.2 Other QA Metadata and Parameters

None.

## Appendix A: Product-Specific Attributes

AIRS Product-Specific Attributes (PSAs) for AIRS products are tabulated below.

**Table 6. Product-Specific Attributes and Their Descriptions.**

| Product-Specific Attribute | Description |
|---|---|
| NumBadData | Number of data points in granule that cannot be processed. |
| NumSpecialData | Number of data points in granule for which the instrument is in a special calibration mode. |
| NumProcessData | Number of data points in granule whichare present and can be processed. |
| NumMissingData | Number of data points in granule with missing data. |
| NumLandSurface | Number of data points within the granule with land fraction greater than 90%. |
| NumOceanSurface | Number of data points within the granule with land fraction less than 10%. |
| NumGeoQA | Number of data points in granule in which a geolocation error was detected. |
| OrbitPath | Orbit number within the repeating set of 233 orbits. |
| ScanLineCount | Number of scan lines within the granule, corresponding to GeoTrack. |
| NumTotalData | Number of data points in granule. |
| AIRSGranuleNumber | Granule number within the set of 240 possible within a day (or 4 possible if RaObs). |
| AIRSGranuleCycleNumber | A counter which indicates one less than the number of times the granule has been processed with the current PGEVersion at the ProductGenerationFacility. It is also the last three digits of LocalGranuleId and is used to assure uniqueness of that field. |
| NodeType | String denoting whether granule is completely Ascending or Descending, or transitional with value NorthPole or SouthPole. |
| ProductGenerationFacility | A single letter which denotes the location where this granule was processed. This will help mark granules not produced at the GDAAC. Valids to be the same as for ProcessingCenter. |
| PopCount | Number of popcorn events within granule, I.e., number of times that an AIRS channel used in the Level 2 retrieval has suffered a sudden discontinuity of dark current. |
| DCRCount | Number of times a Direct Current Restore was executed for any module in granule. |

| | |
|---|---|
| CalibrationMode | All special calibration modes employed within granule. |
| VISDarkAMSUFOVCount | Number of AMSU-A footprints that are uniformly dark in the Level 1B VIS/NIR and are thus likely to be uniformly clear. |
| VISBrightAMSUFOVCount | Number of AMSU-A footprints that are uniformly bright in the L1B VIS/NIR and are thus likely to be uniformly cloudy. |
| PhotoCalibrationOn | Indicates whether photometric calibration source was turned on in the granule. |
| EngDataFormatPacket1 | All engineering data formats (EDFs) for flexible engineering packet #1 found in granule. The EDF specifies what information is included in a packet. |
| EngDataFormatPacket2 | All engineering data formats (EDFs) for flexible engineering packet #2 found in granule. The EDF specifies what information is included in a packet. |
| UnProcessedEDF1 | All engineering data formats (EDFs) for flexible engineering packet #1 found in granule but now allowed for by the current decommutation map. These packets cannot be processed. |
| UnProcessedEDF2 | All engineering data formats (EDFs) for flexible engineering packet #2 found in granule but now allowed for by the current decommutation map. These packets cannot be processed. |
| VersionRetrieval | Version of the Total retrieval algorithm (VnnRxxx). |
| NumBadL1B | Number of profiles in granule in which the Level 2 processing was not allowed due to bad Level 1B data. |
| NumBadL1BAMSU | Number of profiles in granule in which the Level 2 processing could not use all or some of the Level 1B AMSU-A data. |
| NumBadL1BHSB | Number of profiles in granule in which the Level 2 processing could not use all or some of the Level 1B HSB data. |
| NumBadL1BAIRS | Number of profiles in granule in which the Level 2 processing could not use all or some of the Level 1B AIRS data. |
| NumBadL1BVIS | Number of profiles in granule for which the Level 1B VIS/NIR data are suspect |
| NumNoPsurfGuess | Number of profiles in granule in which the surface pressure was estimated from climatology rather than forecast. |
| NumNoTuning | Number of profiles in granule with no tuning. |
| NumNoAngCorr | Number of profiles in granule with no angle correction. |
| NumFpe | Number of profiles in granule with floating point exception in retrieval. |
| NumPrecipMW | Number of AMSU-A footprints in granule for which Microwave rain detector is triggered. |
| NumCloudIceMW | Number of AMSU-A footprints in granule for which |

| | |
|---|---|
| | Microwave cloud ice (graupel) detector is triggered. |
| NumClearMW | Number of AMSU-A footprints in granule that MW retrieval classifies as completely clear. |
| NumClearIR | Number of AMSU-A footprints in granule that Infrared retrieval classifies as completely clear. |
| NumClearVis | Number of AMSU-A footprints in granule for which Vis/NIR retrieval classifies as clear at least 98% of the pixels associated with the FOV |
| NumCloudyVis | Number of AMSU-A footprints in granule for which Vis/NIR retrieval detects clouds in at least 80% of the pixels associated with the FOV. |
| NumLowCloudVis | Number of AMSU-A footprints in granule for which Vis/NIR retrieval detects low clouds in at least 80% of the pixels associated with the FOV. |
| InputGranuleCount | Number of granules of AIRS data contributing to this multi-granule product. |
| TruthMatchesCount | Number of Truth observations with at least one AMSU footprint of AIRS Product satisfying the collocation test. |
| NumRetMatches | Number of profiles matched with Truth. |
| CorrelativeDataSource | Type of correlative data matched to AIRS locations and times |
| NumMWStratIrRetOnly | Number of profiles in granule where the microwave and stratospheric infrared stage succeeded but other infrared retrieval stages failed. |
| NumVisInvalid | Number of profiles in granule having bad VIS/NIR Level 2 fields. |
| NumRetInvalid | Number of profiles in granule where all retrieval stages (Microwave-Only, Initial, Final) failed. |
| MoonInViewMWCount | Number of scanlines in granule with the moon in the Microwave space view. |
| NumSunGlint | Number of data points in granule with possible sun glint. |
| LonGranuleCen | Longitude of the center of the granule in degrees. |
| LatGranuleCen | Latitude of the center of the granule in degrees. |
| LocTimeGranuleCen | Local time at the center of the granule in minutes from midnight. |
| ParentGranCollectionName | The Collection Name of the Parent Granule of Summary Browse Data, used by EDG to find and return the IDs and associated metadata of the parent science granule. |
| SourceVersionCode | A single character used to distinguish between different deliveries of truth from the same source for the same time |
| SourceTypeVariant | Distinguishes particular ARM/CART sites or particular static truth location sets |
| L2ProcessedFlag | Distinguish matchup files based on whether or not they have been processed through Level-2 in matchup format |
| MatchupLevel | Distinguish Matchup files based on whether the AIRS data |

| | |
|---|---|
| | they contain is only Level-1B MW, all of Level-1B, or Level-2 (which may also contain L1B) |
| Synoptic Time | Distinguish PREPQC-derived files based on nominal synoptic time |
| MasterGranCollectionName | Used in browse subset products to transfer the information about the parent collection longname & versioned that the browse PGEs will need to fill PSA ParentGranCollectionName. |

## Appendix B: QA Inventory Metadata

Inventory Metadata fields relevant to the AIRS Level 1B QA are discussed in Chapter 6 above, and also in the current AIRS Calibration Plan (see Introduction above). Level 1B microwave Inventory Metadata QA fields are also defined in Chapter 5 above. Finally, other QA metadata fields are described in detail in the Processing File Description listed in Introduction.

The following tables list the Product Specific Attributes defined in the March 2000 QA Plan but not included in the current PSAs in Appendix A above. Most are presently implemented as Inventory Metadata and defined in the Processing File Descriptions.

**Table 7** ***Inventory Metadata for All Products***

| Parameter Name | Variable Type | Descriptor |
|---|---|---|
| ***PercentLand*** | Integer | Percentage Land over the granule. |
| ***OrbitPath*** | Integer | The number 1-233 that categorizes the orbit in the repeating set of 233 orbit paths. |
| ***OrbitGeoQA*** | Integer | 32-bit number with each bit corresponding to a possible error |
| ***NumSatGeoQA*** | Integer | Numbers of occurrences of various types of geolocation errors within the granule. |
| ***NumGlintGeoQA*** | Integer | Ditto |
| ***NumMoonGeoQA*** | Integer | Ditto |
| ***NumFtptGeoQA*** | Integer | Ditto |
| ***NumZenGeoQA*** | Integer | Ditto |
| ***NumDEMGeoQA*** | Integer | Ditto |
| ***InputLID*** | Character Array | Parallels InputPointer providing Logical ID string. |
| ***InputVersion*** | Array | Parallels InputPointer providing Version string. |

**Table 8** ***Inventory Metadata for AIRS Level 2 Fields***

| Parameter Name | Variable Type | Descriptor |
|---|---|---|
| **QAPercentPrecipitation** | Float | This field complements the existing |

| | | |
|---|---|---|
| | | QAPercentCloudCover. |
| **VersionMWRet** | String | Version of Microwave-only retrieval (VnnRxxx) |
| **VersionVisRet** | String | Version of Visible retrieval algorithms (VnnRxxx) |
| **VersionFirstRet** | String | Version of Initial Retrieval (VnnRxxx) |
| **VersionFinalRet** | String | Version of Final Retrieval (VnnRxxx) |
| **VersionTuning** | String | Version of Tuning (VnnRxxx) |
| **VersionCloudClear** | String | Version of cloud clearing (VnnRxxx) |

**Table 9** ***Inventory Metadata for AIRS Level 2 Support and QA Subset Products***

| Parameter Name | Variable Type | Descriptor |
|---|---|---|
| ***NumForecast*** | Integer (0-1350) | Number of profiles where Complete forecast guess was used |
| ***NumInvalid*** | Integer (0-1350) | Number of profiles with No valid output |
| ***NumBadTemps*** | Integer (0-1350) | Number of profiles with invalid temp and surface skin temp |
| ***NumBadH2o*** | Integer (0-1350) | Number of profiles with invalid water vapor profile |
| ***NumBadO3*** | Integer (0-1350) | Number of profiles with invalid ozone profile |
| ***NumBadClouds*** | Integer (0-1350) | Number of profiles with invalid cloud parameters |
| ***NumBadLowAtm*** | Integer (0-1350) | Number of profiles with invalid result below 100 mb |
| ***NumSpecialProc*** | Integer (0-1350) | Number of profiles with A special level 2 data processing |
| ***NumNoMW*** | Integer (0-1350) | Number of profiles with MW only retrieval not attempted |
| ***NumNoInitial*** | Integer (0-1350) | Number of profiles with First retrieval not attempted |
| ***NumNoFinal*** | Integer (0-1350) | Number of profiles with Final retrieval not attempted |
| ***NumMWFpe*** | Integer (0-1350) | Number of profiles with floating-point exception in MW retrieval step |
| ***NumInitialFpe*** | Integer (0-1350) | Number of profiles with floating-point exception in Initial retrieval step |
| ***NumFinalFpe*** | Integer (0-1350) | Number of profiles with floating-point exception in Final retrieval step |
| ***NumMWRetCode*** | Integer (0-1350) | Number of profiles where return code status of MW retrieval not zero |
| ***NumCloudIce*** | Integer (0-1350) | Number of profiles with Cloud ice present in FOV |
| ***NumIccTooCloudy*** | Integer (0-1350) | Number of profiles with Initial cloud clearing pass too cloudy |
| ***NumIccLowContrast*** | Integer (0-1350) | Number of profiles with Initial cloud clearing pass contrast too low |
| ***NumIccLowContrast*** | Integer (0-1350) | Number of profiles with Initial cloud clearing pass contrast too low |
| ***NumIccBadRad*** | Integer (0-1350) | Number of profiles with Initial cloud clearing pass cloud cleared radiances don't match clear guess - reject the IR retrieval |

| | | |
|---|---|---|
| ***NumBad1st*** | Integer (0-1350) | Number of profiles where initial retrieval failed |
| ***NumBad1stCc*** | Integer (0-1350) | Number of profiles where first cloud clearing failed |
| ***NumBad1stRegres*** | Integer (0-1350) | Number of profiles where regression guess failed |
| ***NumBad1stPhys*** | Integer (0-1350) | Number of profiles where first physical retrieval failed |
| ***NumFccTooCloudy*** | Integer (0-1350) | Number of profiles where Final cloud clearing pass too cloudy |
| ***NumFccLowContrast*** | Integer (0-1350) | Number of profiles where Final cloud clearing pass contrast too low |
| ***NumFccBadRad*** | Integer (0-1350) | Number of profiles where Final cloud clearing pass cloud cleared radiances don't match clear guess - reject the IR retrieval |
| ***NumBadFinal*** | Integer (0-1350) | Number of profiles where Final retrieval failed |
| ***NumBadFinalCC*** | Integer (0-1350) | Number of profiles where final cloud clearing failed |
| ***NumBadFinalSurf*** | Integer (0-1350) | Number of profiles where final surface ret failed |
| ***NumBadFinalTemp*** | Integer (0-1350) | Number of profiles where final temp ret failed |
| ***NumBadFinalH2o*** | Integer (0-1350) | Number of profiles where final water vapor ret failed |
| ***NumBadFinalO3*** | Integer (0-1350) | Number of profiles where final ozone ret failed |
| ***NumBadFinalCloud*** | Integer (0-1350) | Number of profiles where final cloud ret failed |
| ***NumBadCcCldRet*** | Integer (0-1350) | Number of profiles where Cloud clearing and cloud ret are inconsistent |
| ***NumMWIRRetDiffer*** | Integer (0-1350) | Number of profiles where Microwave and IR temperature retrieval differ too much - reject final IR retrieval |
| ***NumBadMWLowResid*** | Integer (0-1350) | Number of profiles with Microwave residuals in lower atmosphere too large - reject final IR retrieval |
| ***NumFinalAMSURet*** | Integer (0-1350) | Number of profiles with nonzero finalAMSURet |
| ***NumFinalHSBRet*** | Integer (0-1350) | Number of profiles with nonzero finalHSBRet |
| ***NumFinalCloudRet*** | Integer (0-1350) | Number of profiles with nonzero finalCloudRet |
| ***NumFinalSurfRet*** | Integer (0-1350) | Number of profiles with nonzero finalSurfRet |
| ***NumFinalTempRet*** | Integer (0-1350) | Number of profiles with nonzero finalTempRet |
| ***NumFinalH2oRet*** | Integer (0-1350) | Number of profiles with nonzero finalH2oRet |
| ***NumFinalO3Ret*** | Integer (0-1350) | Number of profiles with nonzero finalO3Ret |
| ***NumFinalCh4Ret*** | Integer (0-1350) | Number of profiles with nonzero finalCh4Ret |
| ***NumFinalCoRet*** | Integer (0-1350) | Number of profiles with nonzero finalCoRet |
| ***NumFinalCo2Ret*** | Integer | Number of profiles with nonzero finalCo2Ret |

| | | |
|---|---|---|
| | (0-1350) | |
| ***NumMWRetUsed*** | Integer (0-1350) | Number of profiles with MW-only final retrieval used |
| ***NumIsNight*** | Integer (0-1350) | Number of Night profiles |
| ***NumLowSun*** | Integer (0-1350) | Number of profiles with solar zenith angle > 60 degrees |
| ***NumWideAng*** | Integer (0-1350) | Number of profiles with viewing angle at center of AIRS spot > 50 degrees |
| ***NumVisGlint*** | Integer (0-1350) | Number of profiles with Sun glint condition |
| ***NumBadVisRad*** | Integer (0-1350) | Number of profiles with Vis/NIR radiance out of range |
| ***NumBadVisCldDet*** | Integer (0-1350) | Number of profiles with Cloud detection failed |
| ***NumBadVisCldHgt*** | Integer (0-1350) | Number of profiles with Cloud height failed |
| ***NumBadRefNDVI*** | Integer (0-1350) | Number of profiles with Bad reference Normalized Differential Vegetation Index |
| ***NumBadVisVar*** | Integer (0-1350) | Number of profiles with Variability index invalid |
| ***NumVisClear*** | Integer (0-1350) | Number of profiles where entire FOV is Clear sky |
| ***NumVisCloudy*** | Integer (0-1350) | Number of profiles with Clouds in all Vis/NIR pixels of FOV |
| ***NumVisLowCloud*** | Integer (0-1350) | Number of profiles with Low Clouds in all Vis/NIR pixels of FOV |
| ***NumCirrus*** | Integer (0-1350) | Number of profiles with Cirrus cloud in FOV |

## Appendix C: List of Acronyms

| | |
|---|---|
| ADF | AIRS Design File |
| AIRS | Atmospheric Infrared Sounder |
| AMSU | Advanced Microwave Sounding Unit |
| ATBD | Algorithm Theoretical Basis Document |
| AVHRR | Advanced Very High Resolution Radiometer |
| AVN | Aviation forecast |
| DAAC | Data Analysis and Archive Center |
| ECS | ESDIS Core System |
| EDC | EROS Data Center |
| ESDIS | Earth Science Data and Information System |
| GSFC | Goddard Spaceflight Center |
| HDF | Hierarchical Data Format |
| HSB | Humidity Sounder for Brazil |
| L1A | Level 1A data, as instrument counts |
| L1B | Level 1B data, as calibrated radiances |
| ICD | Interface Control Document |
| L2 | Level 2 data , as retrieved geophysical units |
| IR | Infrared |
| MODIS | MODerate-resolution Imaging Spectroradiometer |
| MUT | Metadata Update Tool |
| NDVI | Normalized Differential Vegetation Index |
| OPS | Instrument Operations |
| PFD | Processing Files Description (listed in Chapter 1). |
| PGE | Product Generation Executive |
| PGS | Product Generation System |
| PSA | Product-Specif Attributes |
| QA | Quality Assessment |
| SPS | Science Processing System |
| SST | Sea Surface Temperature |
| VIS | See VIS/NIR |
| VIS/NIR | Visible and Near Infrared |